

JC10 Rec'd PCT/PTO 20 DEC 2001

JC10 Rec'd PCT/PTO 2.0 DEC 2001

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|---|--------------|--|------------|---------------------------------------|-----|
| INTERNATIONAL APPLICATION NO. PCT ID 000073 | | INTERNATIONAL FILING DATE June 26, 2000 | | PRIORITY DATE CLAIMED July 1, 1999 | |
| 17. <input type="checkbox"/> The following fees are submitted: | | | | CALCULATIONS PTO USE ONLY | |
| Basic National Fee (37 CFR 1.492(a)(1)-(5): Neither international preliminary examination fee (37 CFR 1.482) Nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO (1.492(a)(3)) \$1,040 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO (1.492(a)(5)) \$890.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO (1.492(a)(2)) \$740.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) (1.492(a)(1)) \$710.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT = \$ 740 | | | | | |
| Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)). | | | | \$ | |
| Claims | Number Filed | Number Extra | Rate | \$ | |
| Total Claims | 2 -20= | 0 | X \$ 18.00 | \$ | 0 |
| Independent Claims | 2 -3= | 0 | X \$ 84.00 | \$ | 0 |
| Multiple dependent claim(s) (if applicable) | | | + \$280.00 | \$ | |
| TOTAL OF ABOVE CALCULATIONS = | | | | \$ | 740 |
| Reduction by 1/2 for filing by small entity, if applicable. | | | | \$ | |
| SUBTOTAL = | | | | \$ | 740 |
| Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)). | | | | \$ | |
| TOTAL NATIONAL FEE = | | | | \$ | 740 |
| Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property | | | | \$ | |
| TOTAL FEES ENCLOSED = | | | | \$ | 740 |
| | | | | Amt. refunded | \$ |
| | | | | charged | \$ |
| a. <input checked="" type="checkbox"/> A check in the amount of \$ 740.00 to cover the above fees is enclosed. | | | | | |
| b. <input type="checkbox"/> Please charge our Deposit Account No. 02-4377 in amount of \$ to cover the above fees. A copy of this sheet is enclosed. | | | | | |
| c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 02-4377. A copy of this sheet is enclosed. | | | | | |
| NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status. | | | | | |
| SEND ALL CORRESPONDENCE TO: Louis S. Sorell BAKER BOTTS L.L.P. 30 Rockefeller Plaza New York, New York 10112-4498 | | | | | |
| Attorney: Louis S. Sorell PTO Reg: 32,439 | | | | | |
| 12/20/01 | | | | | |
| Date | | | | | |

BAKER BOTTS LLP



FEE TRANSMITTAL for FY 2002

Patent fees are subject to annual revision.

TOTAL AMOUNT OF PAYMENT

(\$ 170

Complete if Known

| | |
|----------------------|-------------------|
| Application Number | 10/030,333 |
| Filing Date | December 20, 2001 |
| First Named Inventor | Ulrich Lettau |
| Examiner Name | t/b/a |
| Group Art Unit | t/b/a |
| Attorney Docket No. | A34859-PCT-USA |

METHOD OF PAYMENT

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any overpayments to:

Deposit
Account
Number

02-4377

Deposit
Account
Name

Baker Botts LLP

- ☒ Charge Any Additional Fee Required
Under 37 CFR 1.16 and 1.17

- ☐ Applicant claims small entity status.
See 37 CFR 1.27

2. ☒ Payment Enclosed:

- ☒ Check ☐ Credit card ☐ Money
Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE

| Large Entity Fee (\$) | Small Entity Fee (\$) | Fee Description | Fee Paid |
|-----------------------|-----------------------|------------------------|----------|
| 740 | 370 | Utility filing fee | |
| 330 | 165 | Design filing fee | |
| 510 | 255 | Plant filing fee | |
| 740 | 370 | Reissue filing fee | |
| 160 | 80 | Provisional filing fee | |

SUBTOTAL (1) (\$ 0

2. EXTRA CLAIM FEES

| Total Claims | Extra Claims | Fee from below | Fee Paid |
|--------------------|--------------|----------------|----------|
| 20** | 0 | 0 | 0 |
| 3** | 0 | 0 | 0 |
| Multiple Dependent | | | |

| Large Entity Fee (\$) | Small Entity Fee (\$) | Fee Description |
|-----------------------|-----------------------|--|
| 18 | 9 | Claims in excess of 20 |
| 84 | 42 | Independent claims in excess of 3 |
| 280 | 140 | Multiple dependent claim, if not paid |
| 84 | 42 | ** Reissue independent claims over original patent |
| 18 | 9 | ** Reissue claims in excess of 20 and over original patent |

SUBTOTAL (2) (\$ 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

| Large Entity Fee (\$) | Small Entity Fee (\$) | Fee Description | Fee Paid |
|-----------------------|-----------------------|--|----------|
| 130 | 65 | Surcharge - late filing fee or oath | 130 |
| 50 | 25 | Surcharge - late provisional filing fee or cover sheet | |
| 130 | 130 | Non-English specification | |
| 2,520 | 2,520 | For filing a request for ex parte reexamination | |
| 920* | 920* | Requesting publication of SIR prior to Examiner action | |
| 1,840* | 1,840* | Requesting publication of SIR after Examiner action | |
| 110 | 55 | Extension for reply within first month | |
| 400 | 200 | Extension for reply within second month | |
| 920 | 460 | Extension for reply within third month | |
| 1,440 | 720 | Extension for reply within fourth month | |
| 1,960 | 980 | Extension for reply within fifth month | |
| 320 | 160 | Notice of Appeal | |
| 320 | 160 | Filing a brief in support of an appeal | |
| 280 | 140 | Request for oral hearing | |
| 1,510 | 1,510 | Petition to institute a public use proceeding | |
| 110 | 55 | Petition to revive - unavoidable | |
| 1,280 | 640 | Petition to revive - unintentional | |
| 1,280 | 640 | Utility issue fee (or reissue) | |
| 460 | 230 | Design issue fee | |
| 620 | 310 | Plant issue fee | |
| 130 | 130 | Petitions to the Commissioner | |
| 50 | 50 | Processing fee under 37 CFR 1.17(q) | |
| 180 | 180 | Submission of Information Disclosure Stmt | |
| 40 | 40 | Recording each patent assignment per property (times number of properties) | 40 |
| 740 | 370 | Filing a submission after final rejection (37 CFR § 1.129(a)) | |
| 740 | 370 | For each additional invention to be examined (37 CFR § 1.129(b)) | |
| 740 | 370 | Request for Continued Examination (RCE) | |
| 900 | 900 | Request for expedited examination of a design application | |

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$ 170

SUBMITTED BY

Name (Print/Type)

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Registration No.
(Attorney/Agent)

27,551

Complete (if applicable)

Telephone

(212) 408-2562

Signature

Date

9/26/02

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10/04/2002 FREY1

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s) : Lettau et al.
Serial No. : To Be Assigned
Filed : Herewith
For : METHOD AND DEVICE FOR ROLLING A STRIP OF
VARYING THICKNESS
Examiner : To Be Assigned
Group Art Unit : To Be Assigned

Assistant Commissioner for Patents
Washington, DC 20231

PRELIMINARY AMENDMENT

Sir:

Kindly amend the above-identified application before examination as follows:

IN THE SPECIFICATION:

Please substitute the originally-filed specification with the Substitute Specification which is enclosed herewith. A comparison document showing the differences between the translation of the originally-filed specification and the enclosed Substitute Specification is also enclosed herewith.

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- 1. (Amended) A method for rolling a metal strip in a rolling train having at least two rolling stands, and wherein the metal strip has at least two areas of different thicknesses connected via a substantially wedge-shaped transition piece, comprising setting the rolling velocity of a rolling stand during rolling of the transition piece as a function of the rolling stand's forward slip, and as a function of the metal strip's temperature.
2. (Amended) Apparatus for rolling a metal strip in a rolling train having at least two rolling stands, the metal strip having at least two areas of different thicknesses which are connected via a substantially wedge-shaped transition piece, comprising means for setting the rolling velocity of a rolling stand during the rolling of the transition piece as a function of the rolling stand's forward slip and as a function of the metal strip's temperature.--

A "Version With Marked Changes Made" is submitted herewith.

REMARKS

By this Preliminary Amendment, applicants amend originally-filed claims 1-2 to comply with the U.S. Patent and Trademark Office practice and standards. No new matter has been added to the application. Amendments to the claims do not address any issues of patentability, and the amended claims are provided to place the application in better condition for allowance.

Likewise, the amendments to the specification are provided to correct grammatical and syntactical errors in the originally filed application. No new matter has been introduced into the application.

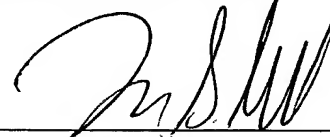
The amendments to the "Claims" are reflected in the attached "Version With Marked Changes Made."

Favorable consideration on the merits is respectfully requested.

Respectfully submitted,

Dated: December 20, 2001

By:



Louis S. Sorell
Reg. No. 32,439

BAKER BOTTS L.L.P.
30 Rockefeller Plaza, 44th floor
New York, New York 10112-0228
(212) 408-2500

Version With Marked Changes Made

In the Claims: WE CLAIM:

1. A method for rolling a metal strip (1) in a ~~rolling train~~, the rolling train having at least two rolling stands, and wherein the metal strip (1) ~~having~~has at least two ~~partial~~ areas (3, 4) of different thicknesses, ~~which are connected to one another via a wedge-shaped or~~ approximatelysubstantially wedge-shaped transition piece (2), and comprising setting the rolling velocity of a rolling stand, during the rolling of the ~~wedge-shaped or approximately~~ wedge-shaped transition piece (2), ~~being set~~ as a function of the rolling stand's forward slip of the rolling stand, characterized in that the rolling velocity of a rolling stand during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2) is also set and as a function of the metal strip's temperature of the metal strip (1).

2. A device Apparatus for rolling a metal strip (1) in a ~~rolling train~~, the rolling train having at least two rolling stands, the metal strip (1) having at least two ~~partial~~ areas (3, 4) of different thicknesses, which are connected to one another via a wedge-shaped or approximatelysubstantially wedge-shaped transition piece (2), and comprising means for setting the rolling velocity of a rolling stand, during the rolling of the ~~wedge-shaped or~~ wedge-shaped transition piece (2), ~~being set~~ as a function of the rolling stand's forward slip of the rolling stand, characterized in that the rolling velocity of a rolling stand during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2) is also set and as a function of the metal strip's temperature of the metal strip (1).

piece, ~~being~~ is set as a function of the forward slip of the rolling stand, ~~in particular~~ particularly
in accordance with the German reference DE--A 197 49 424.

BACKGROUND OF THE INVENTION

[0002] Continuous rolling of a metal strip often leads to changes in thickness of more than 20%, which in turn impose high demands on the setting of the rolling train. On account of the temperature of the strip during hot-rolling, there is ~~only~~ very little room for ~~maneuver~~ maneuvering between looping and necking. This applies all the more if there are changes in thickness of 50% and more. The German reference DE-A 197 49 424 teaches a method for reducing scrap during the hot-rolling of ~~corresponding~~ metal strips. It is an object of the invention to further improve the quality of the rolled product in such a procedure ~~of this type~~.

SUMMARY OF THE INVENTION

[0003] According to the present invention, ~~the object is achieved by a method in accordance with claim 1 and a device for rolling a metal strip in a rolling train in accordance with claim 2, is provided~~ in which, ~~to roll a metal strip is rolled~~ in a rolling train, ~~the rolling train has at least two rolling stands, the metal strip having at least two rolling stands, and wherein the metal strip has at least two partial areas of different thicknesses, which are connected to one another via a wedge-shaped or approximately~~ substantially wedge-shaped transition piece, ~~and the~~ The rolling velocity of ~~at the~~ rolling stand, during the rolling of the ~~wedge-shaped or approximately~~ substantially wedge-shaped transition piece, ~~being~~ is set as a function of the forward slip of the rolling stand and the temperature of the metal strip.

BRIEF DESCRIPTION OF THE INVENTION

[0004] Further advantages and details will emerge from the following description of exemplary embodiments. ~~In the drawings:~~ The present invention is described in greater detail below in connection with the drawings, in which:

FIG. 1 shows Figure 1 illustrates a metal strip of variable thickness;₂

FIG. 2 shows Figure 2 illustrates the curve of set rolling velocities ~~in analogy~~ analogous to the method described in DE-A 197 49 424, 424;

FIG. 3 shows Figure 3 illustrates addition values for the set rolling velocity;₂

FIG. 4 shows Figure 4 illustrates set rolling velocity curves taking account of the forward slip of the rolling stand and the temperature of the metal strip;₂ and

FIG. 5 shows Figure 5 illustrates alternative curves for addition values of the set velocity.

DETAILED DESCRIPTION OF THE INVENTION

[0005] FIG. Figure 1 shows a metal strip 1 of variable thickness resulting from a changeover of the pass sequence during rolling. When ~~it~~ the metal strip 1 exits the final stand of the rolling train, ~~the metal strip 1~~ it has an area 4 having ~~the greater~~ a thickness, which corresponds to the thickness in accordance with ~~the~~ an old pass sequence, and an area 3 ~~of having lesser~~ a thickness, which corresponds to the thickness in accordance with the new pass sequence. Area 4 has a greater thickness than area 3. Between the two areas 3 and 4, the metal strip 1 has a wedge-shaped intermediate piece 2. During the changeover of the pass sequence, the reductions and exit thicknesses of all the rolling stands generally change. Therefore, ~~for example~~ according to DE-A 197 49 424, the rolling stands are changed over from the old pass sequence to the new pass sequence at the appropriate time. FIG. Figure 2 shows how the set rolling velocity is adapted in

analogy to the procedure in accordance with DE-A 197 49 424 for a three-stand rolling train.

This figure illustrates the set values for the rolling velocities v plotted against the time t . ~~V11~~
~~denotes the~~ The rolling velocity of the first stand, is denoted v_{21} , ~~denotes v_{21}~~ , the rolling
velocity of the second rolling stand is denoted v_{21} , and ~~v_{31} denotes~~ the rolling velocity of the
third rolling stand: is denoted v_{31} .

[0006] FIG. Figure 3 shows an addition value Δv_L for the set rolling velocity as a function of time
 t . For the sake of clarity, the scale of the velocity is increased compared to ~~FIG. Figure 2~~ and
~~FIG. Figure 4~~. The addition value Δv_L for the set rolling velocity is set in such a manner that the
temperature of the strip corresponds as accurately as possible to a desired set temperature. The
set velocities are changed by the addition value Δv_L compared to ~~FIG. Figure 2~~. ~~FIG. Figure 4~~
shows the result. ~~In this figure, wherein~~ v_{12} denotes the set rolling velocity of the first stand, v_{22}
denotes the set rolling velocity of the second stand, and v_{32} denotes the set rolling velocity of the
third stand.

[0007] In addition to the curve-4 of the addition value Δv_L shown in ~~FIG. 3~~, ~~FIG. Figure 3 (curve~~
4), Figure 5 shows further possible curves 5, 6, 7, 8 for the addition value Δv_L . The choice of a
suitable curve 4, 5, 6, 7, 8 for the value Δv_L depends on how the desired temperature of the metal
strip is to be set in a suitable way. Moreover, it is possible to take account of boundary or
auxiliary conditions, for example load limits of the roll drives.

[0008] ~~It is particularly advantageous to calculate~~ In a preferred embodiment of the present
invention, the calculation of a suitable curve 4, 5, 6, 7, 8 for the addition value Δv_L by
adaptation, ~~for example~~ calculated by means of a neural network.

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PATENT

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COMPARISON

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2. A deviceApparatus for rolling a metal strip (1)-in a rolling train, the rolling train having at least two rolling stands, the metal strip (1)-having at least two partial areas (3, 4)-of different thicknesses, which are connected to one another via a wedge-shaped or approximatelysubstantially wedge-shaped transition piece (2), andcomprising means for setting the rolling velocity of a rolling stand; during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2), being set as a function of the rolling stand's forward slip of the rolling stand, characterized in that the rolling velocity of a rolling stand during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2) is also setand as a function of the metal strip's temperature of the metal strip (1).

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FIG. 4

BAKER BOTTS L.L.P

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NEW YORK, NEW YORK 10112

TO ALL WHOM IT MAY CONCERN:

Ulrich Lettau, Siegbert Steidl, Wilfried Tautz and Dietrich Wohld, citizens of Germany, residing in Erlangen, Herzogenaurach, Forchheim and Rauschenberg respectively, whose post office addresses are Dummetsweiher 88, 91056 Erlangen, Germany; Schuetzengraben 16D, 91074 Herzogenaurach, Germany; Rotkreuzstr 28 C, 91301 Forchheim, Germany; and Hintere Dorfstr. 3, 91462 Rauschenberg, Germany; respectively, have invented an improvement in:

METHOD AND DEVICE FOR
ROLLING A STRIP OF VARYING THICKNESS

of which the following is a

SUBSTITUTE SPECIFICATION

FIELD OF THE INVENTION

[0001] The invention relates to a method and a device for rolling a metal strip in a rolling train, the rolling train having at least two rolling stands, the metal strip having at least two partial areas of different thicknesses, which are connected to one another via a substantially wedge-shaped transition piece. The rolling velocity of a rolling stand during the rolling of the transition piece is set as a function of the forward slip of the rolling stand, particularly in accordance with the German referene DE-A 197 49 424.

BACKGROUND OF THE INVENTION

[0002] Continuous rolling of a metal strip often leads to changes in thickness of more than 20%, which in turn impose high demands on the setting of the rolling train. On account of the temperature of the strip during hot-rolling, there is very little room for maneuvering between looping and necking. This applies all the more if there are changes in thickness of 50% and more. The German reference DE-A 197 49 424 teaches a method for reducing scrap during the hot-rolling of metal strips. It is an object of the invention to further improve the quality of the rolled product in such a procedure.

SUMMARY OF THE INVENTION

[0003] According to the present invention a method is provided in which a metal strip is rolled in a rolling train having at least two rolling stands, and wherein the metal strip has at least two partial areas of different thicknesses which are connected via a substantially wedge-shaped transition piece. The rolling velocity of the rolling stand during the rolling of the substantially wedge-shaped transition piece is set as a function of the forward slip of the rolling stand and the temperature of the metal strip.

BRIEF DESCRIPTION OF THE INVENTION

[0004] The present invention is described in greater detail below in connection with the drawings, in which:

Figure 1 illustrates a metal strip of variable thickness;

Figure 2 illustrates the curve of set rolling velocities analogous to the method described in DE-A 197 49 424;

Figure 3 illustrates addition values for the set rolling velocity;

Figure 5 illustrates alternative curves for addition values of the set velocity.

DETAILED DESCRIPTION OF THE INVENTION

[0005] Figure 1 shows a metal strip 1 of variable thickness resulting from a changeover of the pass sequence during rolling. When the metal strip 1 exits the final stand of the rolling train, it has an area 4 having a thickness which corresponds to the thickness in accordance with an old pass sequence, and an area 3 having a thickness which corresponds to the thickness in accordance with the new pass sequence. Area 4 has a greater thickness than area 3. Between the two areas 3 and 4, the metal strip 1 has a wedge-shaped intermediate piece 2. During the changeover of the pass sequence, the reductions and exit thicknesses of all the rolling stands generally change. Therefore, according to DE-A 197 49 424, the rolling stands are changed over from the old pass sequence to the new pass sequence at the appropriate time. Figure 2 shows how the set rolling velocity is adapted in the procedure in accordance with DE-A 197 49 424 for a three-stand rolling train. This figure illustrates the set values for the rolling velocities v plotted against the time t . The rolling velocity of the first stand is denoted v_{11} , v_{21} , the rolling velocity of the second rolling stand is denoted v_{21} , and the rolling velocity of the third rolling stand is denoted v_{31} .

[0006] Figure 3 shows an addition value Δv_L for the set rolling velocity as a function of time t . For the sake of clarity, the scale of the velocity is increased compared to Figure 2 and Figure 4. The addition value Δv_L for the set rolling velocity is set in such a manner that the temperature of the strip corresponds as accurately as possible to a desired set temperature. The set velocities are

changed by the addition value Δv_L compared to Figure 2. Figure 4 shows the result, wherein v_{12} denotes the set rolling velocity of the first stand, v_{22} denotes the set rolling velocity of the second stand, and v_{32} denotes the set rolling velocity of the third stand.

[0007] In addition to the curve of the addition value Δv_L shown in Figure 3 (curve 4), Figure 5 shows further possible curves 5, 6, 7, 8 for the addition value Δv_L . The choice of a suitable curve 4, 5, 6, 7, 8 for the value Δv_L depends on how the desired temperature of the metal strip is to be set. Moreover, it is possible to take account of boundary or auxiliary conditions, for example load limits of the roll drives.

[0008] In a preferred embodiment of the present invention, the calculation of a suitable curve 4, 5, 6, 7, 8 for the addition value Δv_L by adaptation, is calculated by means of a neural network.

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Description

- 5 Method and device for rolling a strip of varying thickness

The invention relates to a method and a device for rolling a metal strip in a rolling train, the rolling train having at least two rolling stands, the metal strip having at least two partial areas of different thicknesses, which are connected to one another via a wedge-shaped or approximately wedge-shaped transition piece, and the rolling velocity of a rolling stand, during the rolling of the wedge-shaped or approximately wedge-shaped transition piece, being set as a function of the forward slip of the rolling stand, in particular in accordance with DE-A 197 49 424.

- 20 Continuous rolling leads to changes in thickness of more than 20%, which impose high demands on the setting of the rolling train. On account of the temperature of the strip during hot-rolling, there is only little room for maneuver between looping and necking. This applies all the more if there are changes in thickness of 50% and more. DE-A 197 49 424 teaches a method for reducing scrap during the hot-rolling of corresponding strips. It is an object of the invention to further improve the quality of the rolled product in a procedure of this type.

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- According to the invention, the object is achieved by a method in accordance with claim 1 and a device for rolling a metal strip in a rolling train in accordance with claim 2, in which, to roll a metal strip in a rolling train, the rolling train has at least two rolling stands, the metal strip having at least two partial areas

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FBI LABORATORY

- 1a -

of different thicknesses, which are connected to one another via a wedge-shaped or

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approximately wedge-shaped transition piece, and the rolling velocity of a rolling stand, during the rolling of the wedge-shaped or approximately wedge-shaped transition piece,

4000 7200 10000 12000 14000 16000 18000 20000 22000 24000 26000 28000 30000 32000 34000 36000 38000 40000 42000 44000 46000 48000 50000 52000 54000 56000 58000 60000 62000 64000 66000 68000 70000 72000 74000 76000 78000 80000 82000 84000 86000 88000 90000 92000 94000 96000 98000 100000

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procedure in accordance with DE-A 197 49 424 for a three-stand rolling train. This figure illustrates the set values for the rolling velocities

being set as a function of the forward slip of the rolling stand and the temperature of the metal strip.

Further advantages and details will emerge from the following description of exemplary embodiments. In the drawing:

- FIG. 1 shows a metal strip of variable thickness,
FIG. 2 shows the curve of set rolling velocities in analogy to the method described in DE-A 197 49 424,
FIG. 3 shows addition values for the set rolling velocity,
FIG. 4 shows set rolling velocity curves taking account of the forward slip of the rolling stand and the temperature of the metal strip,
FIG. 5 shows alternative curves for addition values of the set velocity.
- FIG. 1 shows a metal strip 1 of variable thickness resulting from a changeover of the pass sequence during rolling. When it exits the final stand of the rolling train, the metal strip 1 has an area 4 having the greater thickness, which corresponds to the thickness in accordance with the old pass sequence, and an area 3 of lesser thickness, which corresponds to the thickness in accordance with the new pass sequence. Between the two areas 3 and 4, the metal strip 1 has a wedge-shaped intermediate piece 2. During the changeover of the pass sequence, the reductions and exit thicknesses of all the rolling stands generally change. Therefore, for example according to DE-A 197 49 424, the rolling stands are changed over from the old pass sequence to the new pass sequence at the appropriate time. FIG. 2 shows how the set rolling velocity is adapted in analogy to the

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v plotted against the time t . V_{11} denotes the rolling velocity of the first stand, v_{21} denotes the rolling velocity of the second rolling stand and v_{31} denotes the rolling velocity of the third rolling stand.

- 3 -

FIG. 3 shows an addition value Δv_L for the set rolling velocity as a function of time t . For the sake of clarity, the scale of the velocity is increased compared to FIG. 2 and FIG. 4. The addition value Δv_L for the set rolling velocity is set in such a manner that the temperature of the strip corresponds as accurately as possible to a desired set temperature. The set velocities are changed by the addition value Δv_L compared to FIG. 2. FIG. 4 shows the result. In this figure, v_{12} denotes the set rolling velocity of the first stand, v_{22} denotes the set rolling velocity of the second stand and v_{32} denotes the set rolling velocity of the third stand.

In addition to the curve 4 of the addition value Δv_L shown in FIG. 3, FIG. 5 shows further possible curves 5, 6, 7, 8 for the addition value Δv_L . The choice of a suitable curve 4, 5, 6, 7, 8 for the value Δv_L depends on how the desired temperature of the metal strip is to be set in a suitable way. Moreover, it is possible to take account of boundary or auxiliary conditions, for example load limits of the roll drives.

It is particularly advantageous to calculate a suitable curve 4, 5, 6, 7, 8 for the addition value Δv_L by adaptation, for example by means of a neural network.

Patent Claims

1. A method for rolling a metal strip (1) in a rolling train, the rolling train having at least two rolling stands, the metal strip (1) having at least two partial areas (3, 4) of different thicknesses, which are connected to one another via a wedge-shaped or approximately wedge-shaped transition piece (2), and the rolling velocity of a rolling stand, during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2), being set as a function of the forward slip of the rolling stand, characterized in that the rolling velocity of a rolling stand during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2) is also set as a function of the temperature of the metal strip (1).
2. A device for rolling a metal strip (1) in a rolling train, the rolling train having at least two rolling stands, the metal strip (1) having at least two partial areas (3, 4) of different thicknesses, which are connected to one another via a wedge-shaped or approximately wedge-shaped transition piece (2), and the rolling velocity of a rolling stand, during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2), being set as a function of the forward slip of the rolling stand, characterized in that the rolling velocity of a rolling stand during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2) is also set as a function of the temperature of the metal strip (1).

Abstract

Method and device for rolling a strip of varying thickness

A method and a device for rolling a metal strip (1) in a rolling train, the rolling train having at least two rolling stands, the metal strip (1) having at least two partial areas (3, 4) of different thicknesses, which are connected to one another via a wedge-shaped or approximately wedge-shaped transition piece (2), and the rolling velocity of a rolling stand, during the rolling of the wedge-shaped or approximately wedge-shaped transition piece (2), being set as a function of the forward slip of the rolling stand and of the temperature of the metal strip.

FIG. 4

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2/3

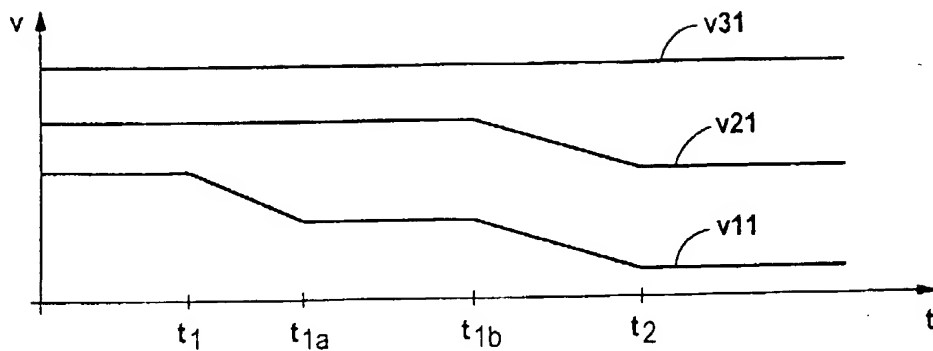


FIG 2

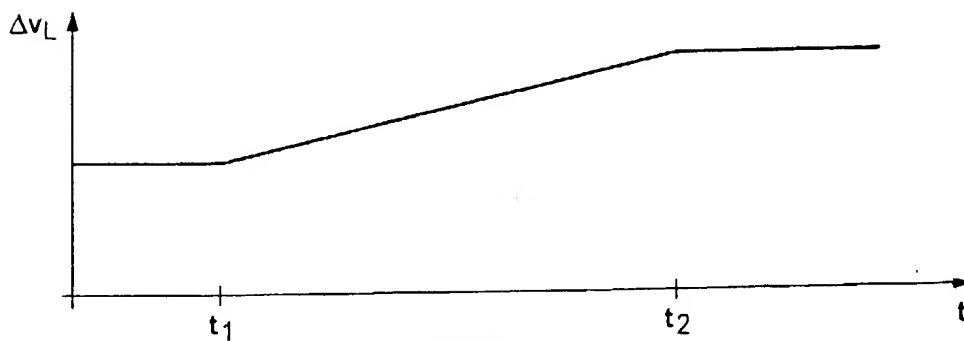


FIG 3

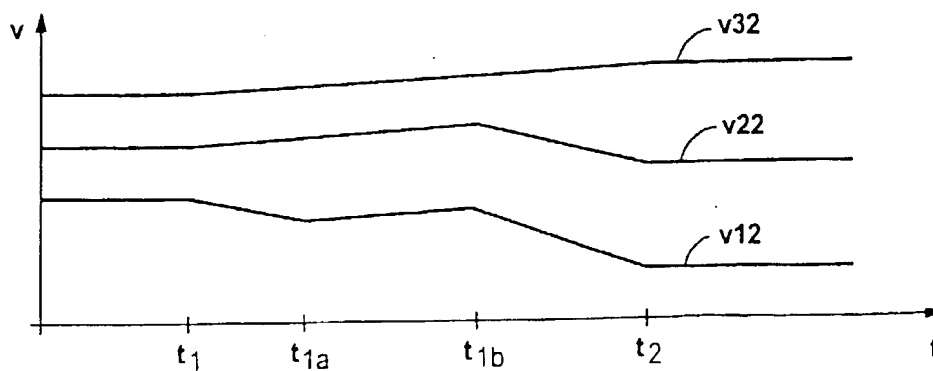


FIG 4

99 P 3445

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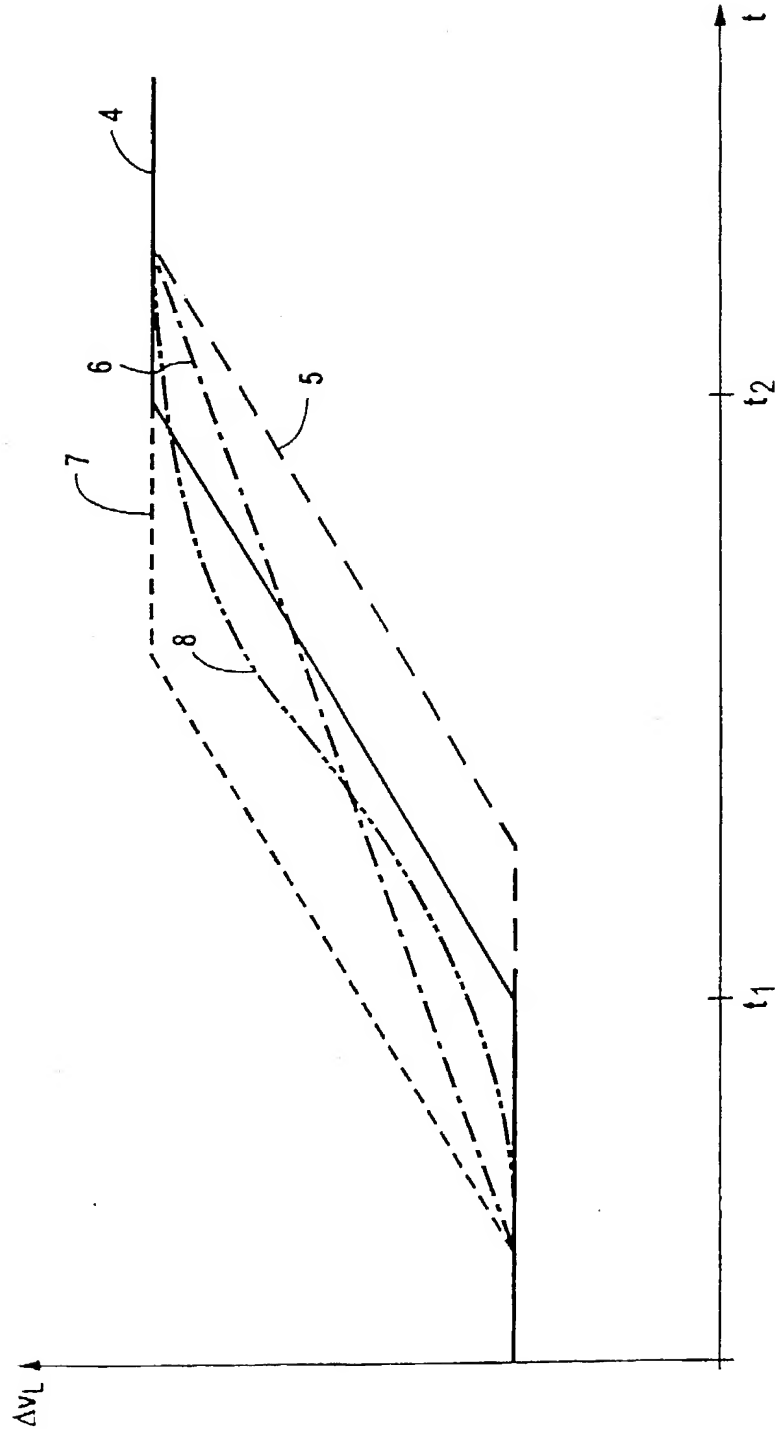


FIG 5



As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method and device for rolling a foil of varying thicknesses

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 26.06.2000 as

PCT international application

PCT Application No. PCT/DE00/02073

and was amended on _____
(if applicable)

(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

19930472.6

DE

01.07.1999

☒

☐

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

Yes
Ja

No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

PCT/DE00/02073

(Application Serial No.)
(Anmeldeseriennummer)

26.06.2000

(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

(Status)
(patentiert, anhängig,
aufgegeben)

pending

(Status)
(patented, pending,
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date D,M,Y)
(Anmeldedatum T, M, J)

(Status)
(patentiert, anhängig,
aufgeben)

(Status)
(patented, pending,
abandoned)

Ich erkläre hiermit, dass alle von mir in der vorliegenden Erklärung gemachten Angaben nach meinem besten Wissen und Gewissen der vollen Wahrheit entsprechen, und dass ich diese eidesstattliche Erklärung in Kenntnis dessen abgebe, dass wissentlich und vorsätzlich falsche Angaben gemäss Paragraph 1001, Absatz 18 der Zivilprozessordnung der Vereinigten Staaten von Amerika mit Geldstrafe belegt und/oder Gefängnis bestraft werden können, und dass derartig wissentlich und vorsätzlich falsche Angaben die Gültigkeit der vorliegenden Patentanmeldung oder eines darauf erteilten Patentes gefährden können.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

German Language Declaration

VERTRETUNGSVOLLMACHT: Als benannter Erfinder beauftrage ich hiermit den nachstehend benannten Patentanwalt (oder die nachstehend benannten Patentanwälte) und/oder Patent-Agenten mit der Verfolgung der vorliegenden Patentanmeldung sowie mit der Abwicklung aller damit verbundenen Geschäfte vor dem Patent- und Warenzeichenamt: (Name und Registrationsnummer anführen)

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (list name and registration number)

Customer No. 21003

And I hereby appoint

Telefongespräche bitte richten an:
(Name und Telefonnummer)

Direct Telephone Calls to: (name and telephone number)

Ext. _____

Postanschrift:

Send Correspondence to:

Baker & Botts, L.L.P.
30 Rockefeller Plaza 10112-0028 New York
Telephone: (001) 212-408-25 62 and Facsimile (001) 212-705-50 20

or

Customer No. 21003

| | | | |
|---|-------|---|------------------------|
| Voller Name des einzigen oder ursprünglichen Erfinders: Dr. ULRICH LETTAU | | Full name of sole or first inventor: Dr. ULRICH LETTAU | |
| Unterschrift des Erfinders | Datum | Inventor's signature <i>[Signature]</i> | Date 4/12/07 |
| Wohnsitz ERLANGEN, DEUTSCHLAND | | Residence ERLANGEN, GERMANY | |
| Staatsangehörigkeit DEUTSCH | | Citizenship GERMAN | |
| Postanschrift DUMMETSWEIHER 88 | | Post Office Address DUMMETSWEIHER 88 | |
| 91056 ERLANGEN DEUTSCHLAND | | 91056 ERLANGEN GERMANY | |
| Voller Name des zweiten Miterfinders (falls zutreffend): SIEGBERT STEIDL | | Full name of second joint inventor, if any: SIEGBERT STEIDL | |
| Unterschrift des Erfinders | Datum | Second Inventor's signature <i>[Signature]</i> | Date |
| Wohnsitz HERZOGENAURACH, DEUTSCHLAND | | Residence HERZOGENAURACH, GERMANY | |
| Staatsangehörigkeit DEUTSCH | | Citizenship GERMAN | |
| Postanschrift SCHUETZENGRABEN 16D | | Post Office Address SCHUETZENGRABEN 16D | |
| 91074 HERZOGENAURACH DEUTSCHLAND | | 91074 HERZOGENAURACH GERMANY | |

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

| | | | |
|--|-------|---|------|
| Voller Name des dritten Miterfinders: Dr. WILFRIED TAUTZ | | Full name of third joint inventor: Dr. WILFRIED TAUTZ | |
| Unterschrift des Erfinders | Datum | Inventor's signature | Date |
| Wohnsitz FORCHHEIM, DEUTSCHLAND | | Residence FORCHHEIM, GERMANY | |
| Staatsangehörigkeit DEUTSCH | | Citizenship GERMAN | |
| Postanschrift ROTKREUZSTR 28 C | | Post Office Address ROTKREUZSTR 28 C | |
| 91301 FORCHHEIM DEUTSCHLAND | | 91301 FORCHHEIM GERMANY | |
| Voller Name des vierten Miterfinders: DIETRICH WOHL | | Full name of fourth joint inventor: DIETRICH WOHL | |
| Unterschrift des Erfinders | Datum | Inventor's signature | Date |
| Wohnsitz RAUSCHENBERG, DEUTSCHLAND | | Residence RAUSCHENBERG, GERMANY | |
| Staatsangehörigkeit DEUTSCH | | Citizenship GERMAN | |
| Postanschrift HINTERE DORFSTR 3 | | Post Office Address HINTERE DORFSTR 3 | |
| 91462 RAUSCHENBERG DEUTSCHLAND | | 91462 RAUSCHENBERG GERMANY | |
| Voller Name des fünften Miterfinders: | | Full name of fifth joint inventor: | |
| Unterschrift des Erfinders | Datum | Inventor's signature | Date |
| Wohnsitz | | Residence | |
| Staatsangehörigkeit | | Citizenship | |
| Postanschrift | | Post Office Address | |
| | | | |
| Voller Name des sechsten Miterfinders: | | Full name of sixth joint inventor: | |
| Unterschrift des Erfinders | Datum | Inventor's signature | Date |
| Wohnsitz | | Residence | |
| Staatsangehörigkeit | | Citizenship | |
| Postanschrift | | Post Office Address | |
| | | | |

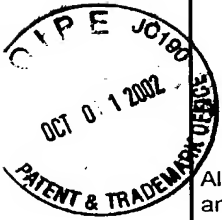
(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).

Declaration and Power of Attorney For Patent Application

Erklärung Für Patentanmeldungen Mit Vollmacht

German Language Declaration



Als nachstehend benannter Erfinder erkläre ich hiermit an Eides Statt:

dass mein Wohnsitz, meine Postanschrift, und meine Staatsangehörigkeit den im Nachstehenden nach meinem Namen aufgeführten Angaben entsprechen,

dass ich, nach bestem Wissen der ursprüngliche, erste und alleinige Erfinder (falls nachstehend nur ein Name angegeben ist) oder ein ursprünglicher, erster und Miterfinder (falls nachstehend mehrere Namen aufgeführt sind) des Gegenstandes bin, für den dieser Antrag gestellt wird und für den ein Patent beantragt wird für die Erfindung mit dem Titel:

Verfahren und Einrichtung zum Walzen
eines Walzbandes mit variierender
Dicke

deren Beschreibung

(zutreffendes ankreuzen)

☐ hier beigefügt ist.

☒ am 26.06.2000 als

PCT internationale Anmeldung

PCT Anmeldungsnummer PCT/DE00/02073

eingereicht wurde und am

abgeändert wurde (falls tatsächlich abgeändert).

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Method and device for rolling a foil of
varying thicknesses

the specification of which

(check one)

☐ is attached hereto.

☒ was filed on 26.06.2000 as

PCT international application

PCT Application No. PCT/DE00/02073

and was amended on _____
(if applicable)

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German Language Declaration

Prior foreign applications
Priorität beansprucht

Priority Claimed

19930472.6

DE

01.07.1999

☒

☐

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

Yes
Ja

No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

(Number)
(Nummer)

(Country)
(Land)

(Day Month Year Filed)
(Tag Monat Jahr eingereicht)

☐
Yes
Ja

☐
No
Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

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PCT/DE00/02073

(Application Serial No.)
(Anmeldeseriennummer)

26.06.2000

(Filing Date D, M, Y)
(Anmeldedatum T, M, J)

(Status)
(patentiert, anhängig,
aufgegeben)

pending

(Status)
(patented, pending,
abandoned)

(Application Serial No.)
(Anmeldeseriennummer)

(Filing Date D,M,Y)
(Anmeldedatum T, M, J)

(Status)
(patentiert, anhängig,
aufgeben)

(Status)
(patented, pending,
abandoned)

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[illegible]

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

And I hereby appoint

Direct Telephone Calls to: (name and telephone number)

Ext. _____

Send Correspondence to:

Baker & Botts, L.L.P.
30 Rockefeller Plaza 10112-0028 New York
Telephone: (001) 212-408-25 62 and Facsimile (001) 212-705-50 20
or
Customer No. 21003

| | | | |
|--|-------|---|------|
| Voller Name des einzigen oder ursprünglichen Erfinders: | | Full name of sole or first inventor: | |
| Dr. ULRICH LETTAU | | Dr. ULRICH LETTAU | |
| Unterschrift des Erfinders | Datum | Inventor's signature | Date |
| Wohnsitz | | Residence | |
| ERLANGEN, DEUTSCHLAND | | ERLANGEN, GERMANY | |
| Staatsangehörigkeit | | Citizenship | |
| DEUTSCH | | GERMAN | |
| Postanschrift | | Post Office Address | |
| DUMMETSWEIHER 88 | | DUMMETSWEIHER 88 | |
| 91056 ERLANGEN DEUTSCHLAND | | 91056 ERLANGEN GERMANY | |
| Voller Name des zweiten Miterfinders (falls zutreffend): | | Full name of second joint inventor, if any: | |
| SIEGBERT STEIDL | | SIEGBERT STEIDL | |
| Unterschrift des Erfinders | Datum | Second Inventor's signature | Date |
| Wohnsitz | | Residence | |
| HERZOGENAURACH, DEUTSCHLAND | | HERZOGENAURACH, GERMANY | |
| Staatsangehörigkeit | | Citizenship | |
| DEUTSCH | | GERMAN | |
| Postanschrift | | Post Office Address | |
| SCHUETZENGRABEN 16D | | SCHUETZENGRABEN 16D | |
| 91074 HERZOGENAURACH DEUTSCHLAND | | 91074 HERZOGENAURACH GERMANY | |

(Supply similar information and signature for third and subsequent joint inventors).

